

The Industrial Production and Use of 1,3-Butadiene

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This presentation provides a brief overview of the production and use of 1,3-butadiene in the United States. Starting as a coproduct of ethylene, the 1,3-butadiene monomer is extracted and purified, then transferred to consumers. Major uses of 1,3-butadiene include the manufacture of styrene-butadiene rubber, polybutadiene rubber, and adiponitrile.

This paper presents a brief overview of 1,3-butadiene production and use, with emphasis on the United States. Isoprene production and use will not be discussed; however, it is very similar to 1,3-butadiene, but on a smaller scale.

1,3-Butadiene is the 34th largest commodity chemical that is produced in the United States (1). In 1987, 1,3-butadiene production was approximately 11.9 billion pounds worldwide and 2.7 billion pounds in the U.S. Most 1,3-butadiene is extracted from a mixed butenes stream (crude butadiene) made as a by-product of ethylene production. This route accounts for approximately 95% of domestic and 85% of worldwide production.

In the U.S. there are 30 ethylene plants located in six states. The crude butadiene streams from these facilities (30 to 60% butadiene depending on ethylene plant feedstock) are processed in 11 extraction units (Table 1), located in Texas and Louisiana. Ten of these extraction units are located in or close to an associated ethylene plant. Crude butadiene is shipped from the remaining ethylene plants by barge or tank car for extraction. Some crude butadiene is also imported from overseas to supplement the domestic supply. There is one "on-purpose" crude butadiene facility, located in Texas, which uses butenes as a feedstock and does not produce the butadiene as an ethylene by-product.

The extraction plants use an extraction solvent such as dimethylformamide or acetonitrile to produce a high-purity (99.0%+) 1,3-butadiene monomer. These plants are typical petrochemical facilities. They are open air and because of the extraction solvent toxicity and butadiene's flammability all hydrocarbons are fully contained. The 1,3-butadiene is handled as a liquified compressed gas.

Heiden and Associates recently surveyed all crude,

monomer, and associated terminal facilities and estimated that approximately 3050 workers are exposed to 1,3-butadiene in these facilities (2). The relatively large exposed population results from 1,3-butadiene's widespread presence throughout the ethylene process. The 1,3-butadiene monomer plant itself only involves a relatively small number of workers because it is highly automated.

1,3-Butadiene consumption in 1987 is estimated at 12.0 billion pounds worldwide and 3.3 billion pounds in the U.S. As in most years, the U.S. demand exceeded its supply, so approximately 500 million pounds of 1,3-butadiene monomer was imported.

The major uses of 1,3-butadiene are in the manufacture of styrene-butadiene rubber, polybutadiene rubber, and other polymers (Table 2). The only major nonpolymer end-use is for manufacturing adiponitrile, a nylon intermediate. There are also several small volume chemical uses, e.g., the production of sulfolane, an industrial extraction solvent.

In the U.S., the majority of 1,3-butadiene is consumed by 18 companies that use 1,3-butadiene at 35 sites in 14 states (Table 3). Historically, there has been little overlap between the 1,3-butadiene monomer producers and

Table 1. U.S. 1,3-butadiene monomer producers.

Company	Location
Amoco Chemicals Co.	Chocolate Bayou, TX
Cain Chemical Co.	Chocolate Bayou, TX
	Corpus Christi, TX
Exxon Chemical Co.	Baton Rouge, LA
	Baytown, TX
Lyondell Petrochemical Co.	Channelview, TX
Mobil Chemical Co.	Beaumont, TX
Shell Chemical Co.	Deer Park, TX
	Norco, LA
Texaco Chemical Co.	Port Neches, TX
Texas Petrochemicals Corp.	Houston, TX

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Table 2. Major U.S. 1,3-butadiene uses (1986).

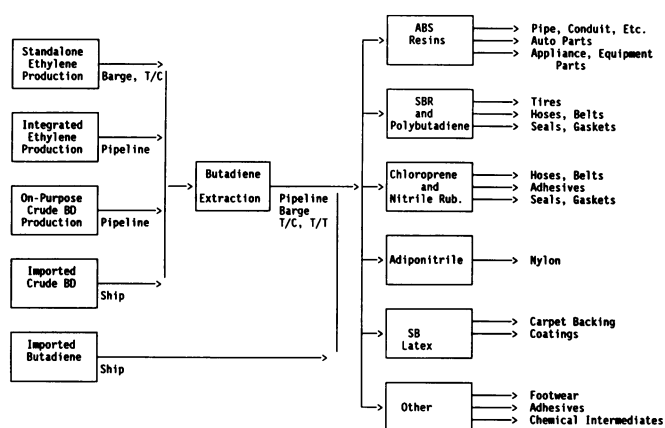
Product	Percent
Styrene-butadiene rubber	32.7
Polybutadiene rubber	22.3
Adiponitrile	12.5
Styrene-butadiene latex	9.9
Chloroprene	6.6
ABS resins	4.4
Nitrile rubber	2.7
Other, including export	3.9

Table 3. Major U.S. 1,3-butadiene consumers.

Company	Location	Use
Ameripol Synpol Co.	Port Neches, TX	SB rubber
American Synthetic Rubber Co.	Louisville, KY	Polybutadiene rubber
B. F. Goodrich	Akron, OH	Nitrile rubber, SB latex
	Louisville, KY	Nitrile rubber
Borg-Warner Corp.	Ottawa, IL	ABS resins
	Washington, WV	ABS resins
Copolymer Rubber and Chemical Co.	Baton Rouge, LA	SB rubber, nitrile rubber
Denka Chemical Co.	Houston, TX	Chloroprene
Diversitech General Corp.	Mogadore, OH	SB latex
Dow Chemical Co.	Allyn's Point, CT	SB latex
	Dalton, GA	SB latex
	Freeport, TX	SB latex
	Midland, MI	ABS resins, SB latex
	Pittsburg, CA	SB latex
E. I. Du Pont de Nemours and Co.	LaPlace, LA	Chloroprene
	Orange, TX	Adiponitrile
	Victoria, TX	Adiponitrile
Firestone Synthetic Rubber and Latex Co.	Lake Charles, LA	SB rubber
	Orange, TX	Polybutadiene rubber
General Tire and Rubber Company	Odessa, TX	SB rubber
Goodyear Tire and Rubber Company	Akron, OH	Nitrile rubber, SB latex
	Beaumont, TX	Polybutadiene rubber
	Calhoun, GA	SB latex
	Houston, TX	SB rubber, SB latex, nitrile rubber
W. R. Grace and Co.	Owensboro, KY	SB latex
Monsanto Co.	Addyston, OH	ABS resins
	Muscataine, IA	ABS resins
Polysar	Chattanooga, TN ^a	SB latex
	Monaco, PA ^a	SB latex
	Orange, TX	Polybutadiene rubber
Reichhold Chemicals, Inc.	Cheswold, DE	SB latex, nitrile rubber
	Kensington, GA	SB latex
Uniroyal Chemical Group	Painesville, OH	Nitrile rubber
Unocal Chemical Co.	Charlotte, NC	SB latex
	LaMiranda, CA	SB latex

^aSale of these facilities to BASF, Inc. is pending.

the users. The producers are generally major petrochemical companies with the 1,3-butadiene extraction plant being a small portion of a very large complex. The users are generally companies associated directly with supplying the end-user (e.g., tire manufacturers) with

**FIGURE 1. 1,3-Butadiene overview.**

raw material. Most sites are relatively small, and the butadiene-consuming process is a significant portion of the site activity. Since mid-1987, no U.S. companies have been both major producers and consumers of 1,3-butadiene. The International Institute of Synthetic Rubber Producers estimates that there are approximately 4200 potentially exposed workers in the 1,3-butadiene consuming plants (3).

The 1,3-butadiene monomer is transported to consumers by a variety of means including pipeline, barge, tank car, and tank truck. Since 1,3-butadiene is a gas at ambient temperature, it is handled as a liquified gas under pressure during transportation. For transport, production, or use the gas is stored either in pressurized vessels or as a refrigerated liquid.

In summary (Fig. 1), we see that 1,3-butadiene is a relatively large volume product that is produced as a coproduct of ethylene manufacture. Its major end-use is in the production of various polymers used to produce tires and nylon.

The bulk of the statistical data presented in this discussion was taken from the 1987 World Butadiene Analysis, published by CMAI, Inc. (4). Their permission to use the information is appreciated.

REFERENCES

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